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DISEASES OF THE CHEST

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Editorial Comment

Newspaper Therapeutics

Some months ago, there appeared in the lay press of a Southern city, and was subsequently relayed throughout the country, an article advocating the use of artificial pneumothorax as a miraculous cure for pneumonia. The article has already had too much publicity, and it is certainly not the intent here to give it more. The American College of Chest Physicians, however, felt it would be delinquent in its duties of guiding leadership and teaching, did it not serve an editorial reprimand against such articles, and a warning caution to its members and readers of these columns, against such practices.

Not only is artificial pneumothorax not a cure for pneumonia; but some years ago, because it did not rest upon a rational basis and was attended with considerable danger, it was abandoned by the specialists in this field as a procedure in the treatment of this disease. This press article, in addition to a glowing sponsorship—and indeed it almost smacked of claims to an original contribution—of an out-moded and dangerous method; recommends to the general practitioner the performance of pneumothorax with dime store equipment. The manometer for registering intra-pleural pressures, and fluoroscopic control—two musts in pneumothorax therapy—are ignored.

Let it be here again emphasized that the insertion of a needle into the chest, and the injection through it of air, is a very significant and serious procedure. It should never be attempted by the inexperienced, and certainly not with improper indications and inadequate equipment. It is to be hoped that this warning comes not too late; and that no physician has been lured from the path of safe and sound orthodox practice by the siren call of this unfortunate article.

C. H. H.

Non-Tuberculous Conditions and Complications of Tuberculosis*

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Practically all tuberculosis institutions admit and treat non-tuberculous conditions. Most of these cases could have been properly diagnosed, if sufficient time had been given to history and examination. Many conditions simulate tuberculosis in their symptomatology and x-ray appearances. Among the most common of these are the various dust diseases. There are two hundred occupations which give rise to dust hazards, but the mineral dusts are most important.

Silicosis today is being recognized as an intricate problem in the industrial world, and is giving the medical and legal professions considerable concern. An increasing number of disability claims are being filed in courts and with industrial accident boards. Several states recognize silicosis as an occupational disease. Its diagnosis depends primarily on a history of adequate exposure, but the symptoms, physical, x-ray, and laboratory examinations must be taken into consideration. Advanced silicosis, complicated by tuberculosis, practically always results fatally. The Woodmen of the World Hospital has admitted over a hundred patients who have been exposed to various kinds of dust. The applying diagnosis in each case was pulmonary tuberculosis.

The following cases illustrate some of the complications of tuberculosis and also some of the mistakes in diagnosis.

Silicosis

Case 1, Fig. 1, A. B. N., age 52, male—He entered the Woodmen of the World Hospital March 5, 1935, with a diagnosis of pulmonary tuberculosis. He had mined coal for 40 years, much of the time in rock. When admitted to the Hospital, the chief complaint was dyspnea, productive cough, weakness and soreness in the chest. These symptoms appeared in 1933, and a diagnosis of pulmonary tuberculosis was made February 12, 1935.

The physical examination, on admission to the hospital, was negative for tuberculosis. Sputum examinations were repeatedly negative for tubercle bacilli. The x-ray (Fig. 1) shows a uniform distribution of pinpoint nodular infiltration throughout both lung fields. A diagnosis of silicosis was made on the history and x-ray, since the physical and laboratory findings were negative for tuberculosis.

Case 2, Fig. 2, A. J. E., age 39—The patient entered the Hospital November 6, 1938, with a diagnosis of pulmonary tuberculosis. He had mined anthracite coal for 28 years. In March 1928, he first noticed cough, weakness, and shortness of breath. These symptoms gradually grew worse, and a diagnosis of tuberculosis was made in 1935.

Our examination revealed altered breath sounds, but no rales were heard in either lung. The Wassermann was negative, and repeated sputum examinations were negative for tubercle bacilli. The x-ray (Fig. 2) is positive for bilateral third stage silicosis.

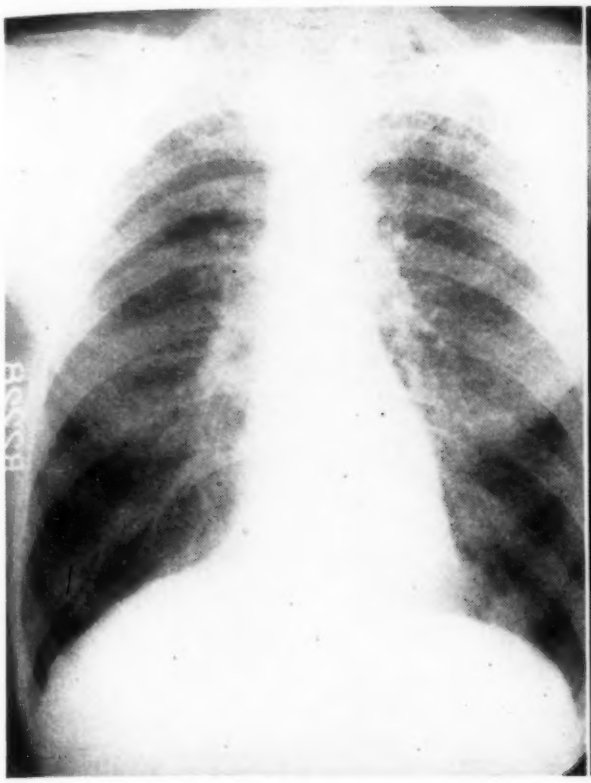
Case 3, Fig. 3, G. P. R., age 58—He entered the Woodmen of the World Hospital June 4, 1934, with a diagnosis of pulmonary tuberculosis. He had mined gold in Lead, South Dakota, for 22 years. Cough and shortness of breath had appeared in 1933, and on admission to the Hospital he had complained of pain in the chest and loss of weight.

On physical examination, no rales were heard in either lung. Sputum examinations were repeatedly negative for tubercle bacilli and the Wassermann test was negative. The x-ray shows a typical silicotic infiltration. The nodules are discrete, and uniform throughout both lungs. Our diagnosis of silicosis was made on history and x-ray.

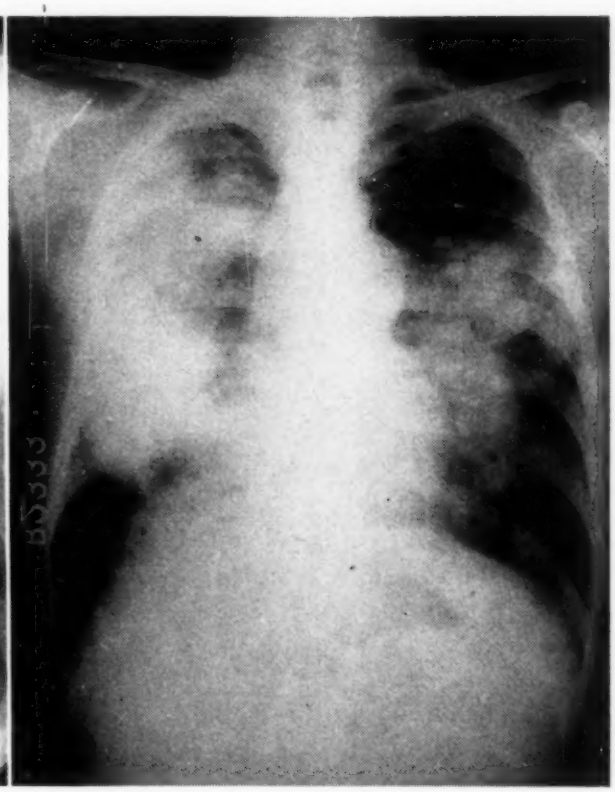
(The next case we present through the courtesy of Dr. W. W. Gay, Chief Surgeon of the American Mining and Smelting Company, El Paso, Texas).

Case 4, Figs. 4-a, 4-b, 4-c, 4-d., M. F. T., age 34, mining engineer—He had worked underground for 10 years. In January 1934, fever and productive cough appeared. He soon felt quite weak and noticed a slight loss of weight. Physical examination was

* From the Woodmen of the World Hospital.



Case 1, Fig. 1—A. B. N., Coal Miner
Diagnosis: Silicosis



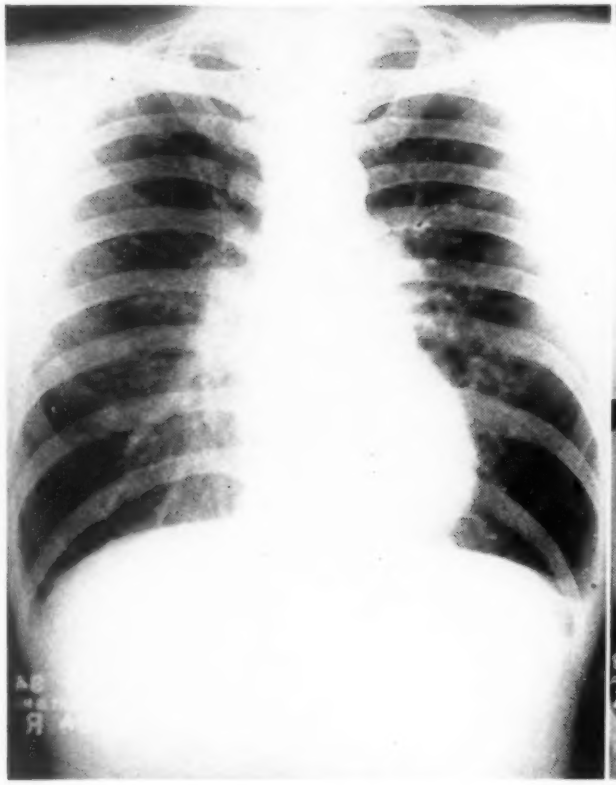
Case 2, Fig. 2—A. J. E., Coal Miner
Diagnosis: Third Stage Silicosis

Case 3, Fig. 3—G. P. R., Gold Miner
Diagnosis: Silicosis

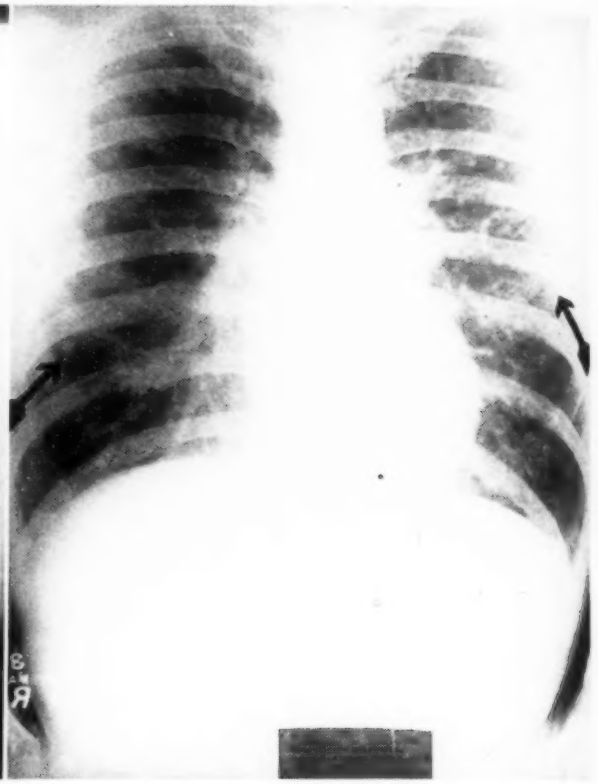
negative for active tuberculosis. The sputum was negative for tubercle bacilli, but was positive for monilia. The first x-ray, (Fig. 4-a) shows a chain of semi-soft appearing nodes between the middle and outer thirds of each lung field. These nodes are typical of pulmonary moniliasis. A diagnosis of first stage silicosis and moniliasis was made at that time.

The second x-ray (Fig. 4-b), taken September 30, 1934, shows that the nodes between the middle and outer thirds of the lung fields had become calcified. The patient at that time was in apparent good health.

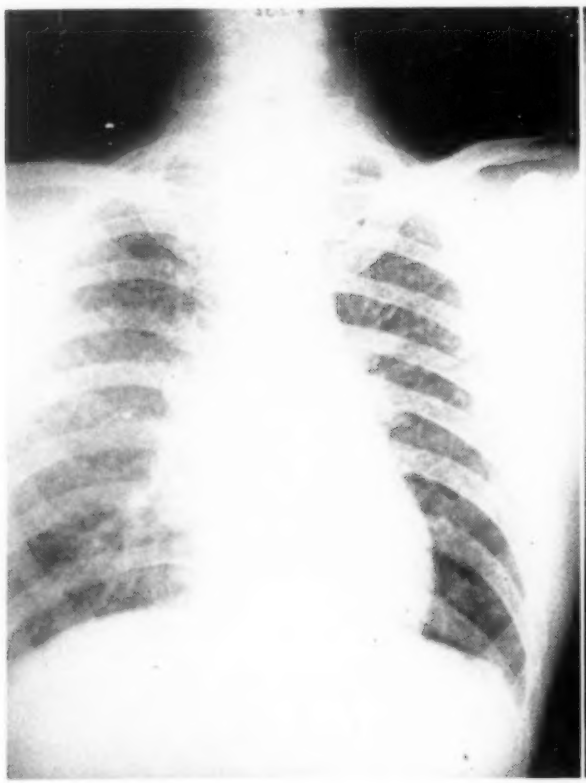
On June 2, 1936, the third x-ray was taken (Fig. 4-c). At that time, the patient was suffering an acute upper respiratory infection. The symmetrical pathology present throughout both lung fields was interpreted as miliary tuberculosis, since the roentgenologist was not familiar with the occupational history. The sputum again was negative for tubercle bacilli, but a culture was positive for monilia. Marked improvement followed hospitalization and treatment.



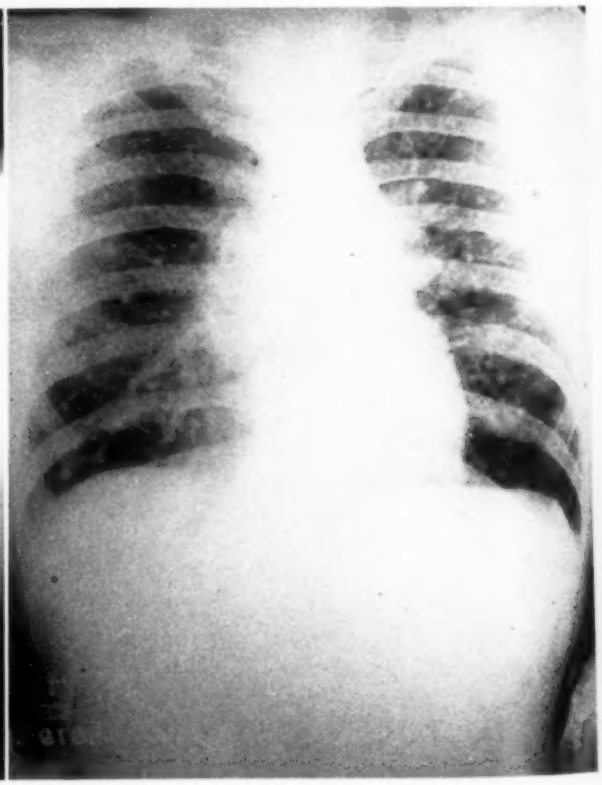
Case 4, Fig. 4-a—M. F. T., Mining Engineer
Diagnosis: First Stage Silicosis and Moniliasis



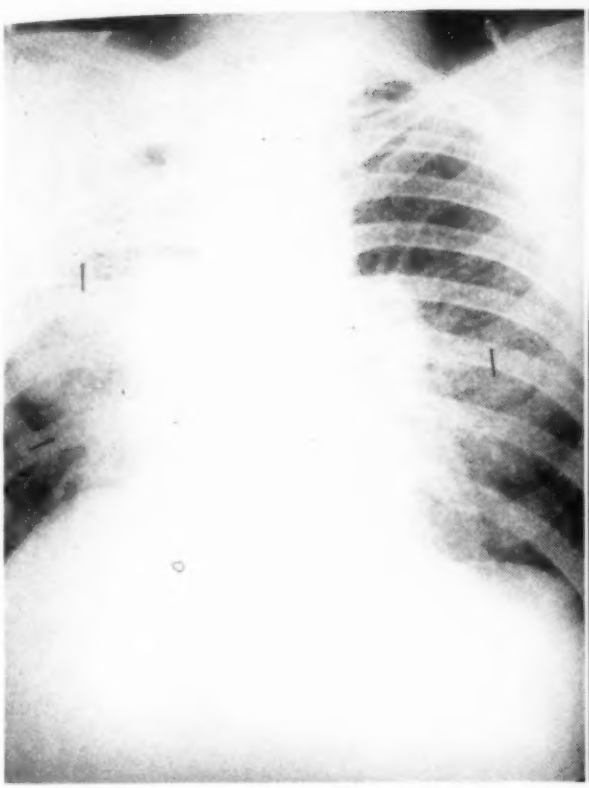
Case 4, Fig. 4-b—M. F. T., Mining Engineer
Diagnosis: First Stage Silicosis and Healed Moniliasis



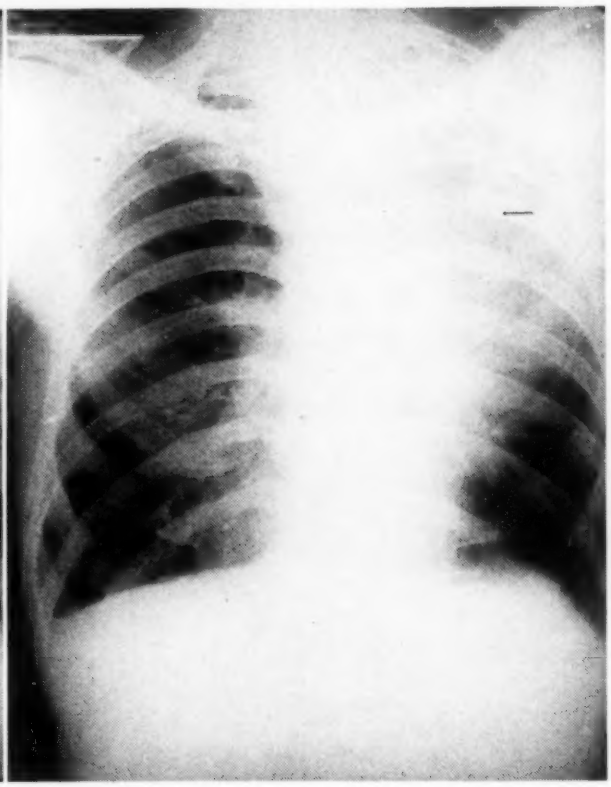
Case 4, Fig. 4-c—M. F. T., Mining Engineer
Diagnosis: Miliary Tuberculosis by Roentgenologist



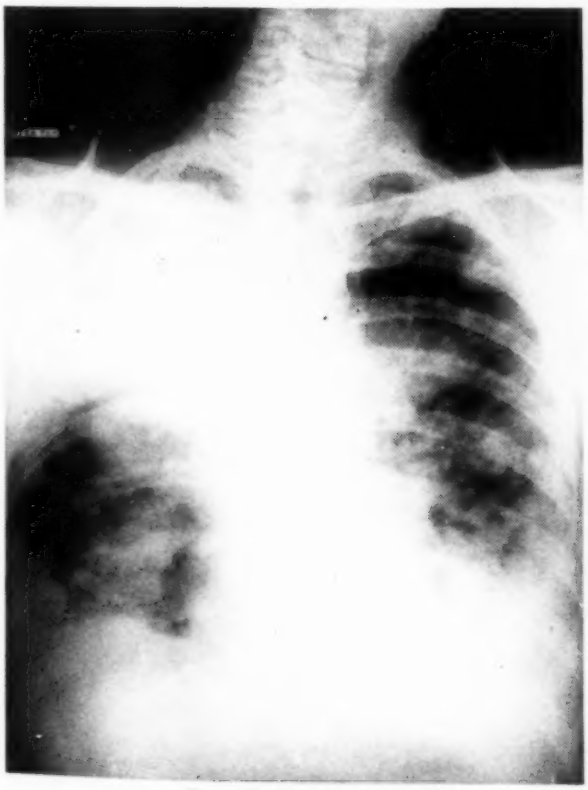
Case 4, Fig. 4-d—M. F. T., Mining Engineer
Diagnosis: Second Stage Silicosis and Healed Moniliasis



Case 5, Fig. 5—A. T., Copper Miner
Diagnosis: Silico-Tuberculosis, right; Silicosis, left



Case 6, Fig. 6—H. A. E.
Diagnosis: Pulmonary Carcinoma

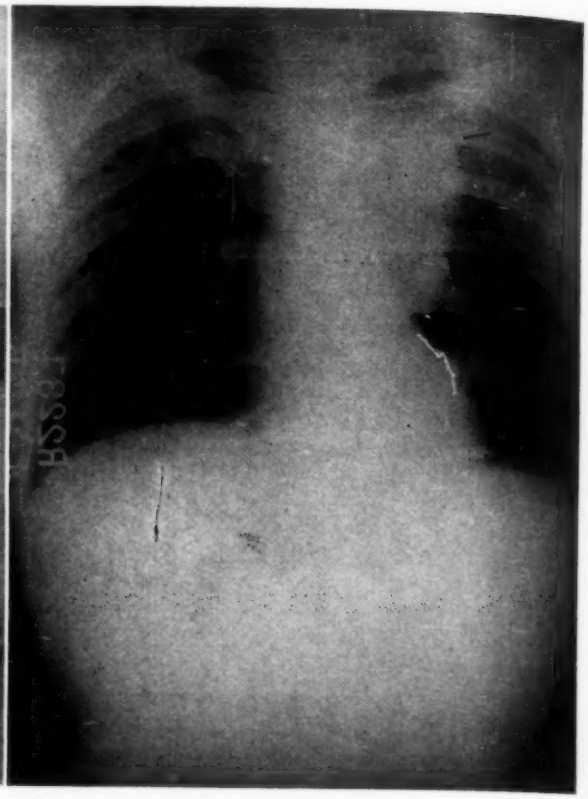


Case 7, Fig. 7—J. P. J.
Metastatic Sarcoma

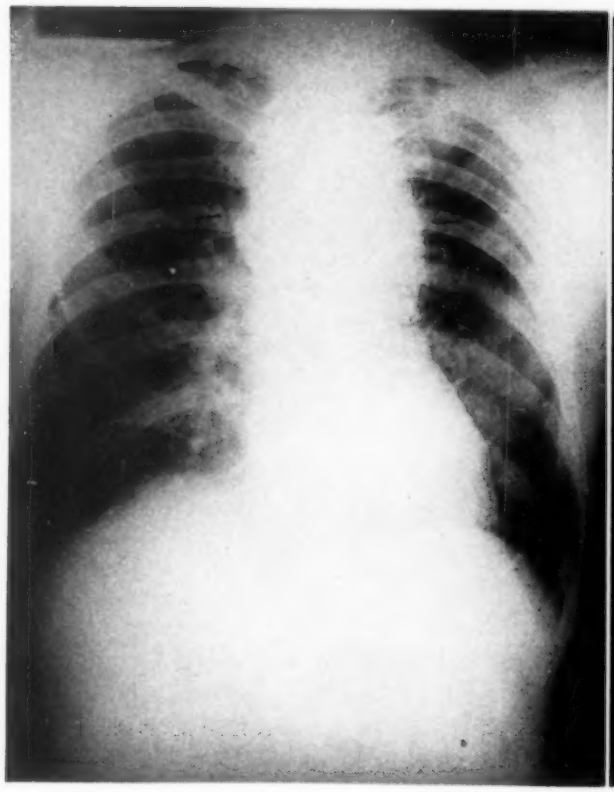
The fourth x-ray (Fig. 4-d), taken on July 7, 1936, shows that most of the acute pathology had subsided, and that the silicosis had passed to the second stage. The calcified nodes are still visible.

Case 5, Fig. 5, A. T., age 48—He entered the hospital in February 1938, with a diagnosis of silicosis and suspected tuberculosis. This patient had mined copper for 25 years. For three and one-half years previous to admission he had experienced shortness of breath, cough, weakness, loss of weight, and substernal pain. On physical examination, fine crackling rales were heard over all of the right lung field. The sputum was positive for tubercle bacilli. The x-ray reveals a soft appearing infiltration in the right lung, which is characteristic of tuberculosis. There is also a discrete, nodular, hard appearing type of infiltration, which is typical of silicosis. In the left lung there is an evenly distributed infiltration that is dense and nodular. Our diagnosis was silico-tuberculosis, right, and silicosis, left.

Case 8, Fig. 8-a—F. Y.
Diagnosis: Hodgkin's Disease (Lymphogranuloma)



Case 8, Fig. 8-b—F. Y.
Diagnosis: Hodgkin's Disease (Lymphogranuloma)



Case 9, Fig. 9-a—J. M. McC.
Diagnosis: Aortic Aneurysm

Case 9, Fig. 9-b—J. M. McC.
Diagnosis: Aortic Aneurysm

Pulmonary Carcinoma

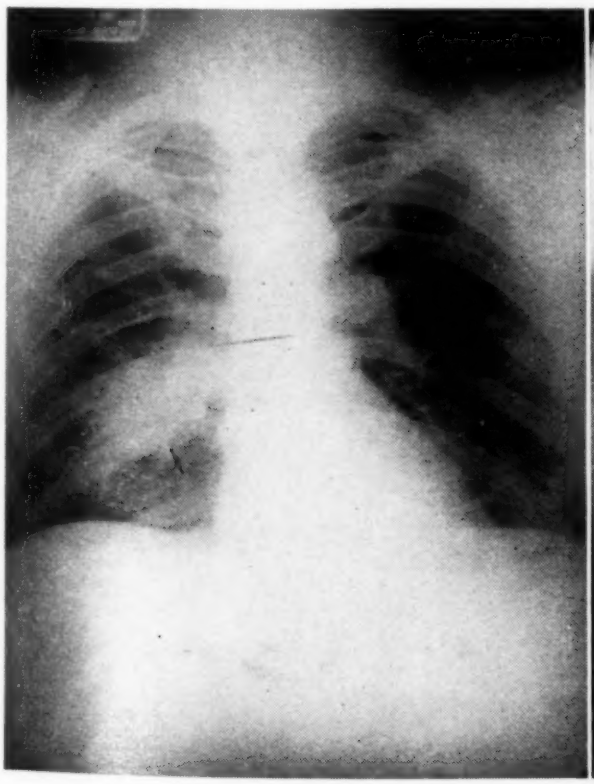
Case 6, Fig. 6, H. A. E., age 52—The patient entered the Woodmen of the World Hospital September 12, 1937, with a diagnosis of pulmonary tuberculosis. In March 1937, the patient had influenza. This was followed by fever, productive cough, dyspnea, malaise, and loss of weight. On physical examination, there was flatness over the upper left chest, and breath sounds were absent. No rales were heard. The sputum was negative on repeated examinations. The tuberculin test was negative on two occasions. The sedimentation rate was high. Our diagnosis was carcinoma of the left lung. The patient died after leaving the hospital. Autopsy by Dr. Fike, of the Steiner Cancer Clinic, revealed bronchiogenic carcinoma, left lung.

Metastatic Sarcoma

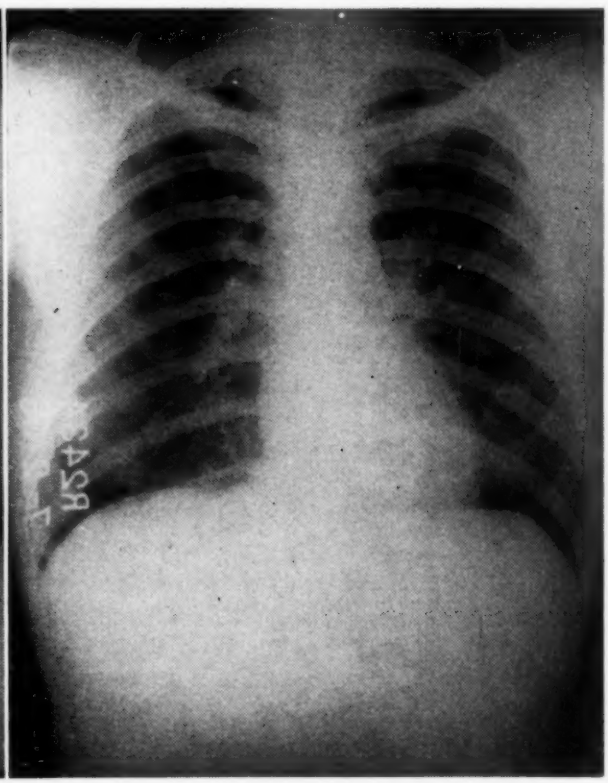
Case 7, Fig. 7, J. P. J., age 26—He entered the hospital August 21, 1924, with a diagnosis of tuberculosis of the right hip and inguinal glands. In January 1924, he first experienced pain in the right groin, and later in the right thigh. A gland was removed from the right inguinal region and a diagnosis of tuberculosis was made from microscopic study. In February 1924, following biopsy, the patient developed pleurisy with effusion, right, and was ill for several weeks. In July 1924, he developed a productive cough, night sweats, and pain in the right thigh. On physical examination, there were no rales, but areas of flatness and dullness were elicited in both lungs. The Wassermann and sputum examinations were negative. X-ray examinations revealed sarcoma of the right thigh, with metastasis in both lungs.

Lymphogranuloma

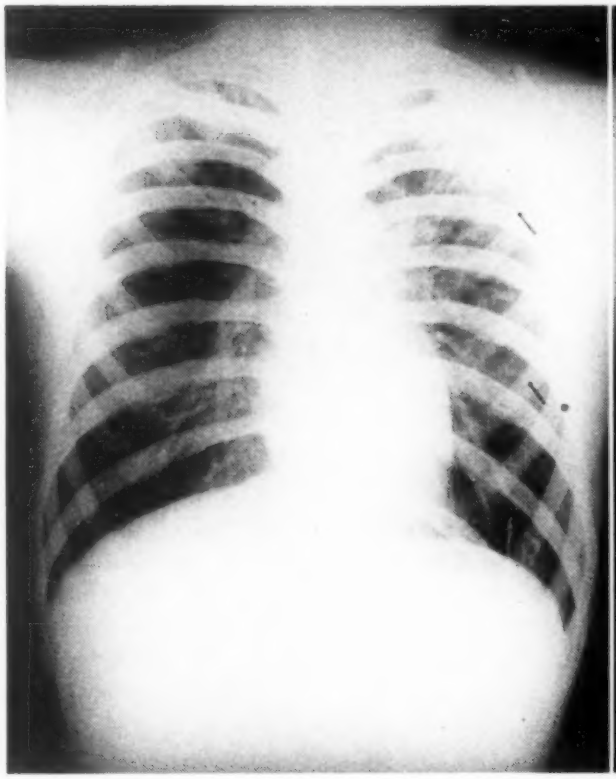
Case 8, Figs. 8-a, 8-b, F. Y., age 33—He entered our hospital April 6, 1935, with a diagnosis of pulmonary tuberculosis and tuberculous adenitis. The patient thought he was in good health until September 1934, when he noticed an abnormal mass in the lower right quadrant and in the right groin. At that time, he had pain in the chest. By March, 1935, he was complaining of productive cough, chest pain, loss of weight and strength. Physical examination was nega-



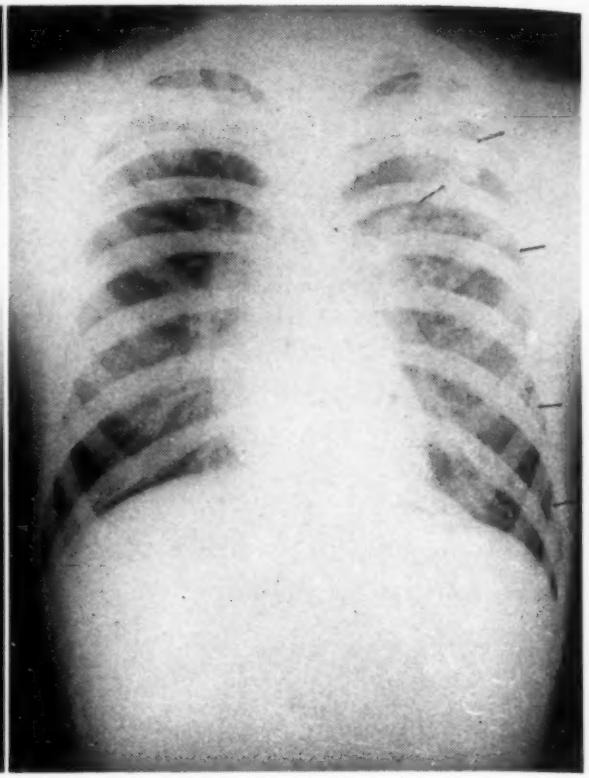
Case 10, Fig. 10—T. V. L.
Diagnosis: Pulmonary Abscess



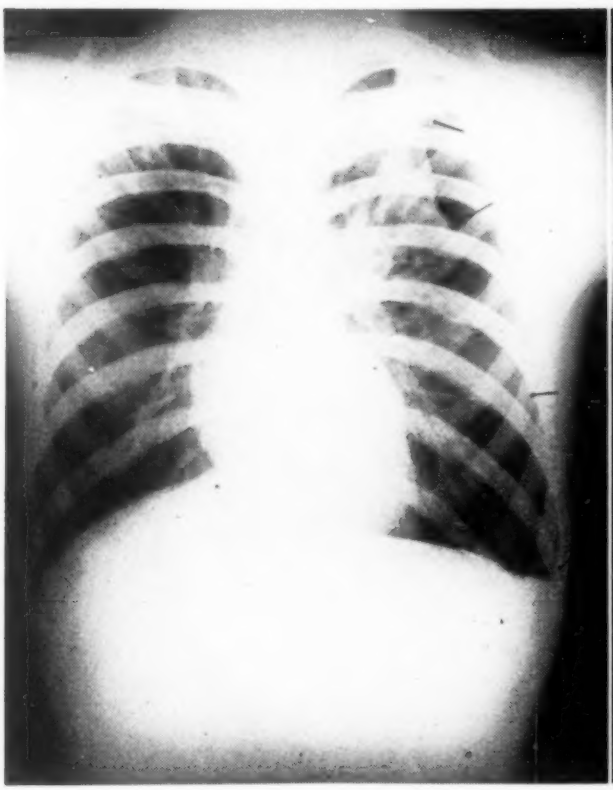
Case 11, Fig. 11—E. R.
Diagnosis: Thyrotoxicosis



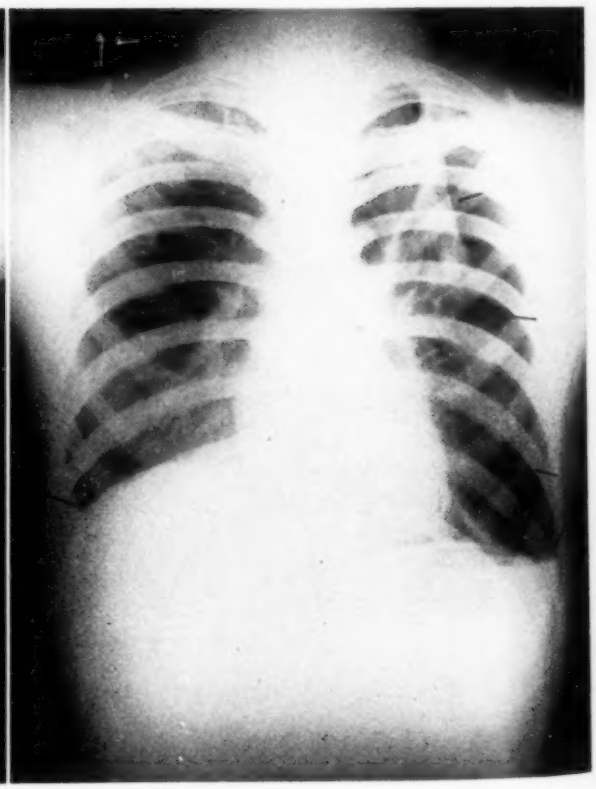
Case 12, Fig. 12-a—J. V. M.
Diagnosis: Pulmonary Bilateral Tuberculosis



Case 12, Fig. 12-b—J. V. M.
Diagnosis: Beginning Pneumothorax, left



Case 12, Fig. 12-c—J. V. M.
Diagnosis: Selective Pneumothorax, left



Case 12, Fig. 12-d—J. V. M.
Diagnosis: Selective Collapse, left; Trace of Fluid, right

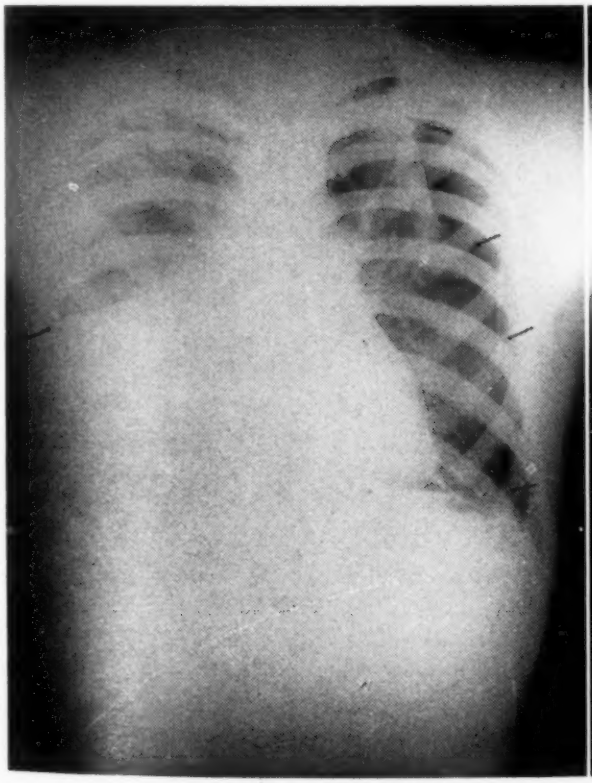
tive for pulmonary tuberculosis, and the sputum was negative on repeated examinations. The x-ray was negative for pulmonary tuberculosis, but there was a visible mass in the left hilum. On the left side of the neck an enlarged gland was noticed, and this gradually grew in size. A section of the gland was removed for microscopic examination, and revealed Hodgkin's disease.

Aortic Aneurysm

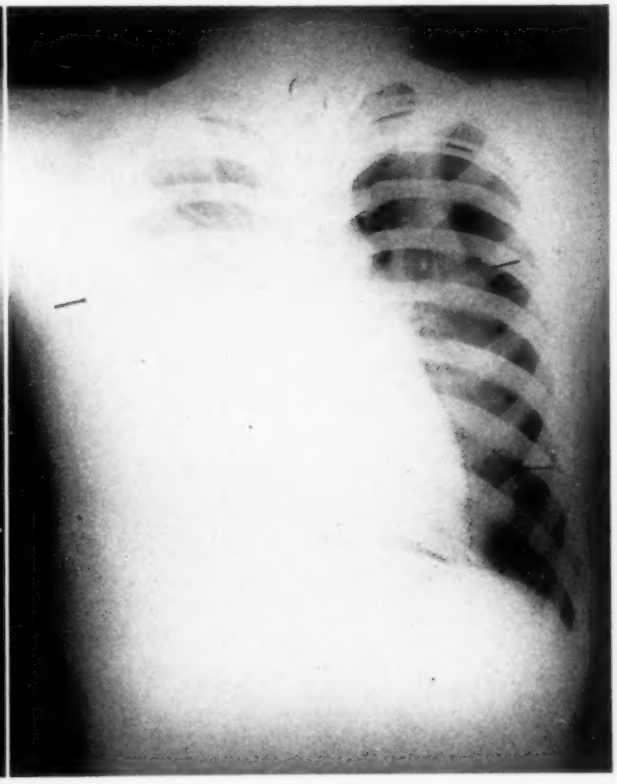
Case 9, Figs. 9-a, 9-b, J. M. McC., age 56—He was admitted to the hospital November 2, 1937, with a diagnosis of pulmonary and laryngeal tuberculosis. Hoarseness had appeared at intervals for three years previous to admission. In October 1937, he developed productive cough, dyspnea, and pain in the chest. Physical examination was negative for tuberculosis, but a bruit was heard over the upper third of the chest anteriorly. The sputum was negative and the Wassermann was 4 plus. The first x-ray (Fig. 9-a) is negative for tuberculosis, but there is a widening of the mediastinum, and the aortic arch is enlarged to the right. The second x-ray (Fig. 9-b) is an oblique, and reveals an enlargement of the arch posteriorly with erosion of the vertebrae. Following discharge from the hospital, the patient died of ruptured aortic aneurysm.

Pulmonary Abscess

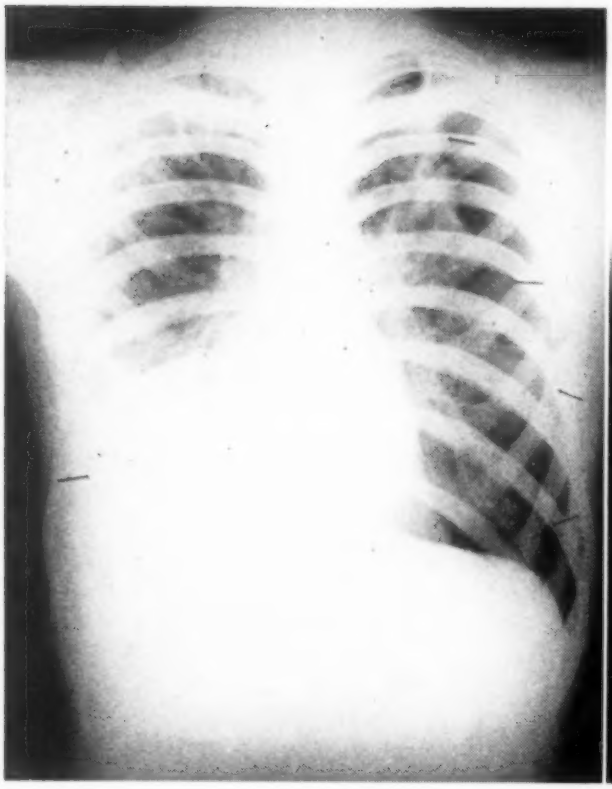
Case 10, Fig. 10, T. V. L., age 31—He entered the hospital June 8, 1936, with a diagnosis of pulmonary tuberculosis. He had been in good health until October 1935, when he had a chill, followed by temperature 104 to 105 for eleven days. The temperature then dropped, but he remained in bed for nine or ten weeks. During that period, there was purulent expectoration and hemorrhage on three occasions. The physical examination was negative except for coarse rales scattered from the angle of the scapula to the base on the right. Sputum examinations were negative for tubercle bacilli. On x-ray examination a diagnosis of pulmonary abscess, middle lobe, was made. The patient died following operation in October 1937. Autopsy confirmed our diagnosis.



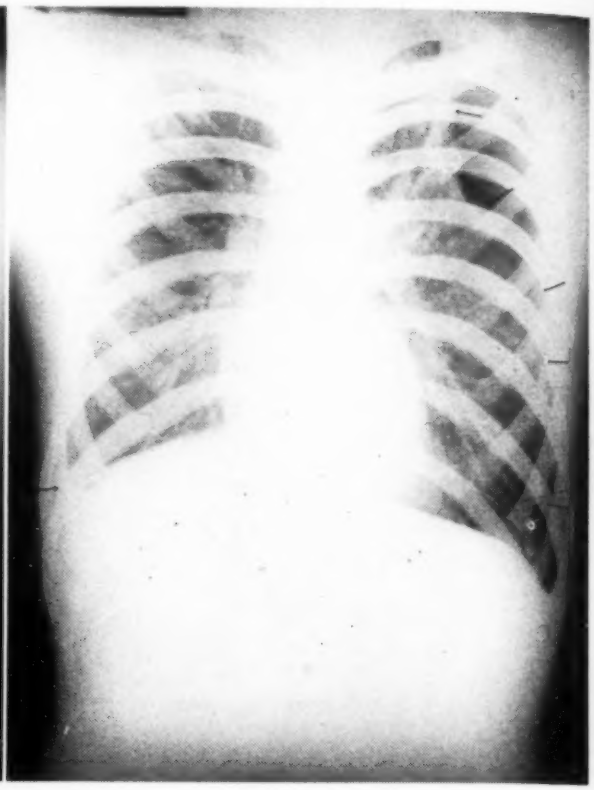
Case 12, Fig. 12-e—J. V. M.
Diagnosis: Selective Collapse, left;
Pleuritic Effusion, right



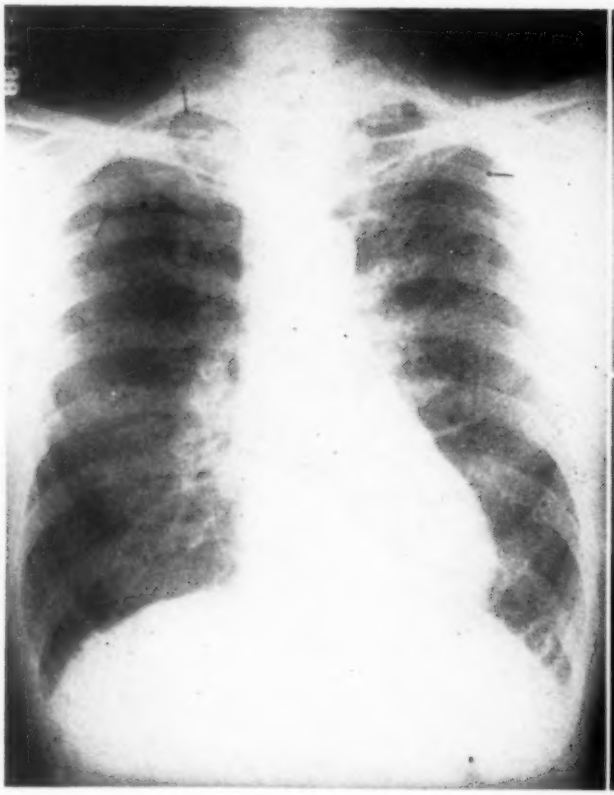
Case 12, Fig. 12-f—J. V. M.
Diagnosis: Selective Collapse, left
Pleuritic Effusion, right



Case 12, Fig. 12-g—J. V. M.
Diagnosis: Selective Collapse, left;
Receding Effusion, right



Case 12, Fig. 12-h—J. V. M.
Diagnosis: Selective Collapse, left;
Trace of Fluid, right



Case 13, Fig. 13a—L. D. H.
Diagnosis: Pulmonary Tuberculosis
Bilateral

Case 13, Fig. 13-b—L. D. H.
Diagnosis: Spontaneous Pneumothorax,
left

Thyrotoxicosis

Case 11, Fig. 11, E. R., age 33—His entrance diagnosis, on June 25, 1936, was pulmonary tuberculosis. There had been no symptoms until December 1935, when he began losing weight. There was a loss of 40 pounds in six months. On admission, he was extremely nervous, irritable, and emotional. Since April, 1936, there had been palpitation of the heart. The physical examination was negative for tuberculosis. Sputum and Wassermann tests were negative. The basal metabolic rate was plus 40. The chest x-ray was negative for tuberculosis. Our diagnosis was exophthalmic goiter and thyrotoxicosis.

Pleuritic Effusion

Case 12, Figs. 12-a, 12-b, 12-c, 12-d, 12-e, 12-f, 12-g, 12-h, J. V. M., age 19—He entered our hospital in April 1938, with a diagnosis of pulmonary tuberculosis. In January 1938, he had influenza, followed by productive cough, loss of weight, strength, and appetite. There had also been occasional night sweats. On admission, there were fine crackling rales in the right apex, and over the upper left lobe. The sputum was positive for tubercle bacilli. The first x-ray (Fig. 12-a) shows a tuberculous infiltration over the upper third of the right lung, and over the upper lobe of the left. Artificial pneumothorax was instituted ten days after admission to the hospital. The various films show the course of collapse on the left, with development of a pleuritic effusion on the right, and its subsequent absorption. Fluid formation on the contralateral side is an uncommon complication in artificial pneumothorax.

Spontaneous Pneumothorax

Case 13, Figs. 13-a, 13-b, L. D. H., age 59—He was admitted to the hospital June 3, 1938, with a diagnosis of pulmonary tuberculosis. In October, 1937, he had developed a productive cough, with shortness of breath, loss of weight and strength. He was treated for malaria by the family physician from September 1937, to May 1938. In December 1937, he suffered an attack of influenza, followed by pain in the left chest. A diagnosis of pulmonary tuberculosis was made at Little Rock, Arkansas, in May 1938. An x-ray (Fig. 13-a), made at that time, shows tuberculous infiltration of both apices and in the first and second interspaces of the left lung. On admission to our hospital, there were no rales, but the breath sounds were increased in intensity. The second x-ray (Fig. 13-b) reveals definite spontaneous pneumothorax, which had occurred May 29, 1938.

Conclusions

1—The symptoms and x-rays of many diseases simulate pulmonary tuberculosis.

2—Careful study should be given to the occupational history before making a diagnosis.

3—Carcinoma of the lung is increasing in frequency, and should be kept in mind where the sputum is negative and the physical findings are not positive for tuberculosis.

5—Pulmonary tuberculosis may be coexistent with other chest diseases.

5—The various laboratory procedures are important in arriving at an accurate diagnosis of chest diseases.

The Diagnostic Problem of Suppuration Within the Chest

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With the recent tremendous advances in the technical side of thoracic surgery, and the application of basic surgical principles to the treatment of infection, suppurative disease and tumors within the thoracic cage, emphasis should be more and more directed to settling the "where and what is it" side of the question, rather than the "what to do" aspects. Also, *when*, rather than *how*, to employ surgical procedures is the timely question, where the physician is confronted with such disease processes.

I do not propose to discuss at length the technical details, nor exact methods of use

of the many procedures that have been developed to aid the physician, but to emphasize the employment of such aids to obtain therefrom the maximum of information, and hence of benefit to the patient.

To illustrate the progress that has been made in the handling of incapacitating disease of the chest, consider the use of pneumonectomy. The first successful total pneumonectomy was reported by Nissen in 1931 on a child of 12, with bronchiectasis of left upper and lower lobes of the lung. The first successful one-stage pneumonectomy (for carcinoma) was reported by Graham and Singer (1933). The total recorded experience (1931 to 1939) of pneumonectomy for non-malignant disease consisted of 46 cases, with 11 operative deaths. To these Overholt[3] adds 7 cases without fatality; all had unilateral suppurative disease of the lung, with or without benign bronchial obstruction and, in each case, the disease was totally incapacitating.

The indications for such radical interference may be outlined somewhat as follows:

Suppurative pneumonitis
Bronchiectatic lung abscess
Bronchiectasis
Multiple lung abscess
Chronic lung abscess
Tuberculous bronchiectasis
Healed empyema with bronchiectasis
Cavernous tuberculosis (unilateral)
Congenital bronchiectasis
Congenital cystic disease of lung, infected

The support for the surgical structure is made up of the diagnostic findings, clinical and laboratory, which brings us to our main point, the adequate use of those facilities already available.

Clinical signs may be extremely variable, especially in the presence of malignant disease of the lungs. Analysis of a series of cases shows symptoms as follows:

Cough, most frequent, 60%
Discomfort in the chest, 40%
Blood-streaked sputum, 40%
G-I symptoms, 10% (in 5% these predominate, most often in presence of bronchial obstruction)
Wheezing, 6% (partial obstruction)

Many other symptoms are found, but often late:

Weight loss, 35%
Dyspnea, 24%
Weakness, 16%

The small stem bronchus tumors without obstruction may produce no symptoms whatever, like the peripheral tumors which do not reach the chest wall. Suppuration secondary to the growth may greatly alter the physical signs. (In 55 per cent of carcinoma cases, evidence exists of associated infection, such as elevated temperature and WBC.)

Before the day of accurate x-ray localization and of bronchoscopy and bronchography, the problem of pus within the chest was one of almost insurmountable mystery. There could be little data for accurately following changes in the patient's condition. Today we have these invaluable aids in thoracic geography and physics, but they are incompletely utilized by many physicians. Let us consider the usual procedure in the case of a patient developing empyema during or after the acute phase of a pneumonia. His chest has been radiographed; it is rayed again in following his course (PA or AP alone, ordinarily). With or without clinical evidence (failure to improve generally, persistent spiking temperature, persistence of signs of localized infection—and if the fluid collection is immediately between lung and chest wall, dullness and diminished sounds of breath and voice), the density in the plates is noted, the complication interpreted, and in due time thoracentesis is done. Let us pause here.

Purulent collections in the thorax may be located:

1) Within the pleural cavity
a) General pleural cavity
b) Interlobar fissures
c) Between lung and pericardium
2) Within the lung itself
a) Abscess, acute or chronic, solitary variety, whether of hematogenous or aspirational etiology
b) Bronchiectasis, whether acquired through recurrent pulmonic infections, or as result of retention of foreign body previously aspirated
c) Either of these, after bronchial obstruction due to neoplasm of the bronchus or to tumor of adjacent organs constricting bronchial lumen
3) Within the mediastinum by extension of infection from pleuro-pulmonary or cervical side, after
a) perforation of esophagus, with cervical deep fascial plane infection extending

downward into the mediastinum

b) rupture of infected lymph node or other infectious process originating in mouth, pharynx, esophagus, lymph nodes or trachea, with extension to mediastinal contents

4) Within the pericardium (from similar etiologic factors).

The ordinary x-ray evidence is based on AP or PA films alone. The lateral view can give additional information as to the location of the pathology, but it is too rarely employed. By its use, it may be determined that the empyema, or other lesion, is large or small, or within the interlobar fissure, or limited to the postero-lateral portion of the chest, etc., etc. "Exploratory thoracentesis" is largely obviated. The condition may be mapped out in three dimensions, and proper drainage based on sound principles of surgical approach instituted at the appropriate stage of the disease, with confidence that pus will be encountered as determined beforehand, and not blindly searched for with repeated punctures through sound lung tissues. The latter yields, often enough, in the case of an interlobar collection, contamination through the needle track, of healthy lung and previously clean pleural cavity. Occasionally, such a procedure will result in accidental and undesired pneumothorax, with infection and a massive empyema.

The diagnostic means at our disposal are many; too few are employed in many instances in which valuable information might be gained by judicious use (in addition to physical examination and sputum examination) of:

Fluoroscopy and Radiographs—PA (or where indicated AP), lateral or oblique views, both right and left; the same in inspiration and expiration (where partial or complete bronchial obstruction is in question) with or without bronchograms; tomograms for determination of pathology at depths or beneath superficial densities such as pleural effusions which conceal lung detail (tomograms will eliminate many "diagnostic punctures" with or without diagnostic pneumothorax where indicated).

Bronchoscopy and Esophagoscopy.

Thoracentesis may be needed. It should, however, follow other procedures of informative value. Closed or open drainage may be instituted, but the necessary mapping, the preliminary staff-work, is done by adequate examination alone. Thoracoscopy and thoracotomy, plainly enough, depend geographically on previous accurate localization by radiography. Bronchoscopy is imperative before operation for acute abscess of the lung, whenever aspiration of foreign body is suspected; also for localization of the bronchopulmonic segment containing the disease, whenever accurate x-ray localization is doubtful. But in most cases, accurate localization is possible through careful study of roentgenograms taken in appropriate positions.

There are certain diagnostic pitfalls in the use of the x-ray, in that so much depends not on the film, but rather on interpretation. Non-putrid pulmonary suppuration (a more severe form of what we ordinarily term bronchopneumonia) with necrosis of lung tissue is often with difficulty differentiated from abscess. The differentiation between simple bronchopneumonia and non-putrid pulmonary suppuration cannot be made by x-ray alone, and particularly not by single films; serial studies are essential.

Suppurative bronchopneumonia is ordinarily diffuse. It may by confluence resemble lobar pneumonia. Localized infection, with obstruction of the bronchus by infected material, may result in obstructive atelectasis or obstructive emphysema. Infected fluid retained behind such obstruction may resemble simple abscess of the lung in an x-ray.

Abscess may be single or multiple, the latter resulting from severe localized infection with insufficient drainage. Solitary abscess, if large, may simulate pyothorax, or pyopneumothorax. Such pathology also may be concealed by a collection of pleural fluid, which when evacuated (or penetrated) reveals the condition of the underlying parenchyma to the x-ray. The presence of empyema presupposes perforation or extension from pulmonary infection, whether abscess or diffuse suppuration. Differentiation of solitary abscess with fluid level from localized pleural collections, whether in the free cavity or in the interlobar fissure, *may* be difficult. Lateral and oblique views are of great value in determining the locale of such collections, and hence give clues to their anatomic location, and to their probable origin.

Purulent bronchitis is almost always ac-

companied by destruction of elastic tissue and permanent damage to, and dilatation of, bronchi. Recurrent infection, persistence of infection (as in unresolved pneumonia or because of failure of atelectatic areas to reopen) increases the possibility of the permanence of such destructive changes. Here contrast media are required for diagnosis of the true state of affairs; simple flat plates of the chest, and even stereos, show only peribronchial shadows, resulting from infiltration in the lymphatic channels of the lung. Bronchograms will demonstrate the dilatation or its absence.

The use of oily contrast media, popularized for many years, is admittedly inconvenient, and even dangerous, because of the persistence in many instances of the foreign material for long periods of time (as much as 2 years in some cases), and (especially in infants and young children) the development of "lipoid pneumonias." The latter have been demonstrated, following repeated instillation of supposedly bland oily medicaments into the pharynx alone in infants. It would be better, from the standpoint of clarity of subsequent roentgen examination, and also for the safety of the patient, to use water-soluble materials, easily expelled from the bronchi, and which give equally as great contrast as the iodized oils. Lilienthal recommends the use of 30 per cent iodoform in 33.5 per cent syrup glucose (U.S.P.). This material has the advantage of the oily solution, in that it is somewhat viscid and does not flow readily enough to diffuse into the parenchyma before it can be pictured, and is not retained more than one to two weeks. Because of the possibility of hypersensitivity to iodoform, patch testing with the powder is suggested before its use for bronchography. The objections to the use of iodoform (as in tuberculosis) are no more than can be brought against any iodized oil. Other substances that might be employed are the uroselectan group of contrast substances, halogenated fluorescein derivatives, which have long been used satisfactorily by the intravenous route for pyelograms, and the gall-bladder dyes, also water-soluble fluorescein derivatives, halogenated. The retention of iodized oils, also, may hinder application of radiation therapy in bronchial or pulmonic carcinoma, because of burns resulting from secondary radiation.

Bronchography is necessary in suspected tumors. The shadows of parenchymal neoplastic infiltration are associated with those resulting from bronchial obstruction and atelectasis, whether partial or complete, with those of hilar adenopathy, with those of bronchial dilatation below the point of obstruction, with those of pulmonary suppuration, and with those of the post-obstruction necrosis and cavitation that occur with many obstructive lesions, and with most neoplasms. These secondary shadows produce great polymorphism in the appearance of bronchogenic carcinoma and render essential the use of bronchoscopy and bronchography in orientation and description. Infiltrative forms seem to respond better to radiation, hence it becomes essential to determine as precisely as possible the limits of extension of the process in the bronchial walls, in the hilar nodes, etc., and so to map out portals of entry for radiation. It may thus be possible to arrange the application of the large dosages of radiation required in therapy of these epithelial tumors, without massive irradiation of unduly large amounts of lung tissue and resultant radiation sickness in the first instance, and post-radiation fibrosis of lung later. The more nodular, circumscribed growths are more amenable to surgical attack; the differentiation must be made (short of biopsy) by the visual and graphic methods now at hand, which are therefore essential to the selection of the optimum mode of attack upon the particular neoplasm.

Proper interpretation of x-rays in carcinoma of the lung depends upon an understanding of the pathology involved. It has been shown by Fried that most carcinoma of lung is of bronchial epithelial origin, starting in basal cells of the mucosa. Commonly, tumors arise in the wall of large bronchi near bifurcations, and spread to nearby hilar and mediastinal nodes. Perforation through the bronchial wall into the parenchyma may be followed by extension along peribronchial lymphatics, or occlusion of the bronchus by constriction. Diffuse parenchymal involvement may produce necrosis and formation of pulmonary abscess. Rarely, a growth may involve an entire lobe, resembling lobar pneumonia. Rarely, a carcinoma may arise in the wall of a small distal bronchus, and appear as a round or wedge-shaped parenchymal in-

filtration. With these, central nodes are late in being involved, but often there is a band of infiltration from peripheral lesion to regional node.

The use of films made in inspiration and expiration for the determination of obstructive atelectasis or emphysema is often an aid in diagnosis of neoplasm of foreign body obstructing a bronchus, and supplies a pathologic basis for a process that at first may appear puzzling. One of the commonest early evidences of carcinoma in the lung is atelectasis, based on bronchial obstruction whether internal or external. Parenchymal extension may later give rise to necrosis and abscess formation, which often are the presenting features. With non-malignant origin of abscess, there may often be a slight relative increase of pressure on the affected side, resulting in a slight mediastinal shift toward the normal side. Also in abscess of neoplastic origin, the wall is frequently more irregular than with a purely inflammatory lesion; the use of tomographs may aid in differentiation by such information. Shadows of pathology at definite depths within the lung will frequently resolve the difficulty of knowing what may lie beneath an effusion, or pleural thickening, or an empyema, etc. Likewise, they are of great aid in determining the effectiveness of closure of cavity in thoracoplasty or pneumothorax cases.

The frequent occurrence of bronchiectasis of the upper lobe has been recognized since the popularization of bronchography. Formerly it was thought to be essentially a pathologic process of the lower lobes alone. It has been shown, both by Churchill and by O'Brien, that of patients undergoing lobectomy for lower lobe bronchiectasis, about 33 per cent have involvement also of either the lingula of the left upper lobe, or of the right middle lobe itself. Such findings emphasize the importance of using all the diagnostic means at our command (which are numerous and effective in visualization) to obtain as complete as possible a picture of the problem in hand before proceeding to attack it radically. Therefore, bronchography, too, should be done not only with films in AP or PA, but also in obliques, to demonstrate as clearly as possible the individual lower lobe bronchi and divisions. The retrocardiac branches of the left lower lobe will be easily demonstrated in the left anterior oblique, and only in that position will they show clearly, especially if both sides are filled at the same time with contrast medium.

The diagnostic aids discussed are few, numerically, but their applications are many and important. The x-ray should be employed with full recognition of the great amount of information that can be derived from it—not only PA but AP, lateral, oblique, and any special views required in the individual case, with the use of inspiration and expiration to show obstruction and atelectasis, with bronchography to map out hidden pathology and the bronchoscope to determine its character and the best mode of attack; with tomographs for information at specific depths and beneath densities that otherwise negate the penetrative value of the rays; with the use of pneumothorax where indicated for additional contrast or to determine freedom of the pleural space (especially in the handling of peripherally situated tumors). The proper use of the means at hand will multiply the effectiveness of the medical practitioner, and will yield solutions to many problems that at first sight are too difficult to be handled except with a large organization and armamentarium. The more complete the information available before the institution of therapy in cases of suppuration within the thoracic cage, the safer the patient. This is by no means a complete discussion of all diagnostic means, but enough has been said to indicate the value of thorough investigation and detection of underlying pathologic bases for the sometimes mysterious appearing manifestations of pyogenic processes in the chest.

Kayenta Sanatorium

References

1 Sussman, Marcy L.: "Roentg. Aspects of Nonputrid Pulmonary Suppuration," *Am. J. Roentg. and Rad. Therapy*, 40: 345, 1940.
2 Neuhof, H., and Touroff, A. S. W.: "Acute Putrid Abscess of Lung, iv. Surg. Treatment and End Results in 86 Cases," *J. Thor. Surg.*, 9: 439, 1940.
3 Overholt, R. H.: "Pneumonectomy for Malign. and Suppur. Disease of the Lung," *J. Thor. Surg.*, 9: 17, 1940.
4 Neuhof, H., and Copleman, B.: "Interlobar Perforation of Abscess of Lung," *Surg.*, 7: 236, (Feb.) 1940.
5 Gray, H. K., and Woodruff, R.: "Infected Dermoid Cyst of Thorax Simulating Chronic Empyema," *Minn. Med.*, 23: 781, 1940.
6 Rosenblatt, M. D.: "Putrid Lung Abscess, Pathogenesis, Prognosis, and Treatment," *J. Thor. Surg.*, 9: 294, 1940.

7 Farinas, P. L.: "Bronchographic Exam. of Bronchial Carcinoma," *A. J. Roentg. and Rad. Therapy*, 44: 325, (Sept.) 1940.
8 Olds, J. W., and Kirklin, B. R.: "Primary Carcinoma of the Lung," *A. J. Roentg. and Rad. Therapy*, 44: 357, 1940.
9 O'Brien, W. J.: *J. Thor. Surg.*, 6: 278, 1937.
10 Churchill: *J. Thor. Surg.*, 6: 286, 1937.
11 Lilienthal, Howard: "Aqueous Preparations to Supplant Oil in Roentgenography," *A. J. Roentg. and Rad. Therapy*, 39: 564, 1938.

Surgery in Pulmonary Tuberculosis

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Blitzkrieg, unfortunately, cannot be waged against the tubercle bacillus and tuberculosis has never been susceptible to overnight cure. Known by scientists and Egyptian archeologists to have been pathogenic for mankind at least ten thousand years ago, it has remained through the centuries a disease in which recovery is measured in months and years rather than days and weeks. Although this constitutes a source of regret, it is moderated by an understanding of progress recently made, not only in diagnosis but also in therapy, and particularly surgical therapy.

For generations an attitude approaching therapeutic nihilism was adopted toward the cure of phthisis. Hippocrates, himself, briefly considered the use of pneumothorax, but this procedure did not become of practical value until the investigations of Forlanini in the latter nineteenth century. At about that time, Koch's isolation of the tubercle bacillus and advances in physical diagnosis furnished the diagnostic aids necessary for the first well-rounded attack on the disease. Following these refinements there developed an appreciation of the value of isolation and the danger of cross-infection, the acceptance of rest as the keystone of therapy and the perfection of the x-ray as a diagnostic maneuver. Each has been an essential step directed toward the eventual elimination of the disease. The fact that this goal is being approached within the twentieth century seems largely due to four factors: (1) adoption of the educational and case-finding program as we know it today, (2) expansion of the sanatorium system, (3) earlier diagnosis by the medical profession, and (4) increasing and more intelligent use of collapse therapy. The last, a comparatively recent advance, will be the subject of this discussion in which accumulated surgical knowledge to date will be summarized and a few personal observations made.

It is true that many remarkable recoveries follow strict bed rest alone but one also sees many cases not responding to this form of treatment. It has been estimated that 90 per cent of all those dying of pulmonary tuberculosis have had, at some time, an indication for collapse therapy which would have offered, in an estimated 50 per cent, a definite chance for cure. This figure, naturally, refers chiefly to artificial pneumothorax but it involves surgical relaxation and collapse as well. Through use of the latter, it has been possible in the past twenty years to increase substantially the number of cured patients returning to their homes with safety to themselves and others and resuming their places as useful members of society. This seems like a worthwhile accomplishment.

In this paper, consideration will be given to all accepted forms of surgical collapse without discussing detailed operative procedure. Pneumothorax, essentially non-surgical, will not be mentioned in detail, although it remains the most widely-used form of collapse therapy, and rightly so. Despite complications and the fact that frequently a satisfactory free pleural space can neither be found nor maintained, its use is often attended by excellent results. It remains the initial and premier collapse weapon directed against tuberculosis, but further reference will be made to it only by virtue of incidental relationship to purely surgical procedures, of which, because of importance, the first to be discussed will be thoracoplasty.

Thoracoplasty

Development of this form of surgery is one of medicine's outstanding recent achievements. First reported in the decade in which Forlanini advocated therapeutic pneumothorax, thoracoplasty has moved steadily to

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the high position it now holds. Statistically it merits this ranking. According to accepted authorities, in properly selected cases and by employing proper technique, at least 70 per cent of thoracoplasties may be expected to result in cavity closure and sterilization of sputum while a steadily declining mortality of less than 10 per cent may be anticipated. In any hypothetical group of patients not responding to other forms of treatment and not offered supplementary thoracoplasty, the death rate will climb far above this figure; the hope for a negative sputum will certainly not approach three out of four. The significance of these superior thoracoplastic results is re-emphasized when one recognizes that they occur today in spite of broadened indications for, and lessened contraindications against, this form of surgery. The explanation seems to be a multiple one and numerous factors may be mentioned.

Probably none looms larger than the fact that operative skill and finesse, at first largely incumbent with the few originally advocating the operation, has now been developed by increasing numbers of competent thoracic surgeons. Thoracoplasty is a major surgical procedure, but there are few geographical units of any size in the nation today where some men are not by training and experience qualified to offer the patient a definite hope for success. Consequently, the public is becoming thoracoplasty-conscious and among sanatorium patients there is less resistance, active or passive, to "the rib job." In fact, the patient frequently urges this form of surgery although factors exist that, in the medical mind, contraindicate and prevent its use.

Likewise, tremendous technical strides have been made in carrying out the operation since the early efforts of de Cerenville in 1885. The latter removed only a few short rib segments overlying the cavity he hoped to close. This inadequate approach may, in the light of present day knowledge, be understood to have produced no striking clinical results. Following this initial effort there developed in succession numerous technical modifications advanced by the pioneers in chest surgery, chief of whom were Brauer, Friedrich, Wilms and Sauerbruch. Their procedures ran the gamut from highly shocking complete costectomy (with the exception of the first rib), performed at one operation, to paravertebral thoracoplasty which implied less drastic rib removal confined chiefly to the paravertebral region and performed in more than one stage, and to subscapular thoracoplasty which secured greater collapse by additional removal of rib segments underlying the scapula. These developments resulted successively in a decreasing operative mortality and in an increasingly successful postoperative result, but still left much to be desired. Each was a necessary preliminary stage, however, in the evolution of modern posterolateral thoracoplasty combining, as it does, the good features of its predecessors and limiting their drawbacks. Definitely selective in type of collapse, it differs in employment of multiple stages, with complete removal of the first rib and decreasing lengths of succeeding ribs in posterior as well as lateral and partial anterior segments, and in the removal of corresponding transverse processes. It also implies stages performed in rather close succession before onset of significant periosteal regeneration, unless some definite contraindication should have arisen. Although many minor modifications of technique are used today, this remains the general outline followed.

Related items of importance, aside from technique, in reducing today's operative mortality and improving surgical results include: (1) choice and skilled administration of proper anaesthesia, (2) better preoperative selection of cases and (3) a rational scheme of postoperative care.

Many forms of anaesthesia are used throughout the country, inhalation generally being preferred. The agents employed are many, including chiefly nitrous oxide-oxygen and cyclopropane. In spite of its explosive possibilities, tendency to cardiac arrhythmia, etc., the latter has impressed the writer as the most satisfactory, although it is true that the ideal agent has possibly not yet been found or perfected. Cyclopropane, however, should not be used in the presence of a live cautery or coagulating unit, both of considerable value in the technical performance of thoracoplasty. Avertin and local, or novocaine alone are also available and even spinal has been employed, although not generally recommended. Some men advocate intratracheal anaesthesia which permits aspira-

tion of the tracheobronchial tree at will. Any such procedure tending to reduce the danger of postoperative atelectasis and basal or contralateral spread is a highly desirable one. In our experience, however, routine bronchoscopic aspiration before the patient has left the table and attention to frequent changes of position postoperatively have seemed adequately to care for this complication. The routine preoperative use of atropine is not desirable because of its known tendency to thicken bronchial secretions and encourage atelectasis.

Better preoperative selection of cases is now practiced, at the same time admitting that more patients are finally considered suitable for thoracoplasty. This is generally restricted to those between fifteen and forty-five with productive or predominantly productive disease which has shown no recent flare-up. Ideally, the lesion should be unilateral; but if bilateral, the pathology in the opposite lung should be static. (Frequently, however, postoperative re-activation of apparently quiescent contralateral lung disease can be controlled by induction of a low-grade pneumothorax). Estimation of vital capacity, evaluation of functional performance of heart and kidneys and use of other laboratory aids are of considerable value in considering advisability of surgery. Thoracoplasty, like blood transfusion, should be performed in a semi-anticipatory fashion if possible and not reserved for a dramatic last-minute gesture when there is little or no chance of survival and/or success. It is not, by custom or experience, recommended in those with advanced renal, tracheobronchitic or gastrointestinal disease. Occasionally, however, tuberculous laryngitis clears, under continued local treatment, following closure of pulmonary cavities by this form of surgery.

Experience has shown that a lung, therapeutically collapsed by pneumothorax, should re-expand to its maximum extent before surgery. It is both safer and easier to adjust intrapleural pressures preoperatively with a co-operative patient than later when he is semi-conscious and in need of rest and when decompression must be done somewhere near the operated area. We also believe to be rational the performance of a preliminary stabilizing anterior upper stage in those who, requiring thoracoplasty, could not survive the classical posterior stage. This seems in many cases to prepare patients better for subsequent posterior approach.

Better postoperative management embraces many factors. One of the most important, we believe, is maintenance in an atmosphere of tent oxygen for at least twelve hours after surgery; if tissue anoxemia can be minimized, the patient's chances are brightened considerably. Of almost equal value is supplying adequate fluid, electrolyte and glucose immediately postoperatively, preferably intravenously. Possible bad results of an electrolyte-fluid balance disturbance in any surgical case are known to all; after thoracoplasty, although vomiting is not a frequent complication, such an imbalance can lead to a distinctly bad prognostic situation. Indication for transfusion is an elastic one and is only occasionally observed. When used, however, results are frequently as dramatic as those of transfusion following other types of major surgical insult. We have found coramine the best of available postoperative cardio-respiratory stimulants.

No discussion of thoracoplasty would be complete without mentioning its great value in treatment of tuberculous empyema and emphasizing certain factors of importance in preparing such patients for surgery. In active lung tuberculosis complicated by empyema, either purely tuberculous or secondarily infected, thoracoplasty is definitely indicated if the patient is already in shape, or can be (fortunately) prepared for it. Blood transfusions have a particular indication here, and the longer the delay before surgery, experience has shown, the greater the possibility of progressively crippling toxemia, amyloidosis, or spread to uninvolved lung tissue. Open preoperative drainage of an empyema should almost never be instituted unless secondary infection has been proven bacteriologically and, as a corollary, closed lavage is the method of choice in preparing pure tuberculous empyema for surgery. Development of an accompanying persistently patent bronchopleural fistula leaves little room for doubt as to the advisability of thoracoplasty. Such patients, if untreated, are doomed to increasing morbidity and a relatively early death if the fistula remains patent; and often also even if it closes spontaneously, since secondary infection of the pleural cav-

ity will frequently have occurred.

In pure tuberculous empyema with slight or no pulmonary activity it has seemed to us, as to many others, advisable to give pleural lavage a thorough trial. For this purpose we have found azochloramide in saline (1:3300) somewhat superior to other products. Possibly much of its action is mechanical but a beneficial chemical effect seems to be exerted as well. Quite a few cases so treated will clear; those that do not will require surgical obliteration of the empyema cavity, an indication especially marked whenever, unfortunately, secondary invaders have made their appearance. Those cases in which a tuberculous empyema has cleared but the lung has refused to re-expand will also suggest thoracoplastic obliteration of the residual space. Here the diaphragm is practically always elevated and a phrenic paralysis will be of no value.

The Schede type thoracoplasty implying regional excision of the stiffened parietal pleura and overlying intercostal structures, scarification of the visceral pleura and obliteration of the empyema space with live pedicled muscle implants is, through limitation of space mentioned briefly and merely to emphasize the disadvantages of allowing an empyema to remain untreated. Although often the only satisfactory procedure available for treatment of old chronic empyema, its relatively high mortality and technical difficulty of performance are known to all.

Finally, reference should be made to combined prophylactic-therapeutic thoracoplasty. This procedure applies typically, in our minds at least, to discharged cases with fibroid disease, frequently of long standing, which have been considered arrested. Such patients experience sudden hemoptysis and sputum is frequently again found positive. Hemorrhage, it is reasonably assumed, is coming from the old fibrotic, bronchiectatic area of apparently healed disease with little or no x-ray evidence of any new exudative lesion. The patient soon quiets down and all superficial signs of activity disappear. Generally, at this point, we believe, thoracoplasty should be performed if no contraindication exists. By no other means can prevention of a similar recurrence be guaranteed, although it is frequently difficult to convey this idea to a patient who now feels well enough to ask for discharge. We do not, however, agree with those who advocate routine thoracoplasty for early minimal or moderately ad-advanced exudative, non-excavating disease, before all other types of indicated therapy have been given a fair trial.

We have had little experience with extrafascial apicolyis used in conjunction with thoracoplasty but believe the increased risks outweigh its benefits. Many will disagree with this, however.

Extrapleural Pneumonolysis

Somewhere between thoracoplasty and classical pneumothorax lies extrapleural pneumonolysis, comprising selective separation of the lung from the thoracic wall external to the parietal pleura and maintenance of the resulting extrapleural space by paraffin, air, or other material. Consideration of this procedure is indicated only when preliminary collapse maneuvers, including chiefly intrapleural pneumothorax and intrapleural pneumonolysis, have proved ineffective or inadvisable. Frequently used as a preoperative thoracoplastic procedure in certain patients considered too poor risks for the latter, it is also often curative in itself and can be employed, unlike thoracoplasty, in the presence of active pathology in the opposite lung. Applicable chiefly for localized collapse of apical and subapical cavities, it has the added advantage of being relatively free from operative shock and results in minimal dimunition of vital capacity and less pronounced abnormal chest wall excursion.

The preliminary surgical technique of extrapleural pneumonolysis is standardized, whether completed by paraffin pack or extrapleural pneumothorax. Its success, anatomically, depends on exposure of the delicate endothoracic fascia and a careful peeling off of the underlying parietal pleura from the chest wall in this plane, preferably by blunt finger gauze disection. Use of an intrathoracic source of illumination is of value in completing this procedure and locating any sources of bleeding which must be controlled, generally by temporary packing. In the majority of cases it is possible to free the diseased portion of the upper lung but occasionally one can neither find nor fully develop the cleavage plane and the idea of a pack or extrapleural pneumothorax must be abandoned.

When paraffin is the material selected to maintain the extrapleural pocket, it is inserted in small molded blocks which soon form a homogeneous mass exerting uniform compression on the underlying lung. Enough should be introduced to insure and maintain effective collapse. On the other hand, insertion of excessive quantities will not only place a great strain on the suture line above it but may also encourage erosion of the lung and undesired compression of mediastinal structures. Dangerous dyspnea, as a result, is a possibility although reduction of vital capacity itself is much less than with thoracoplasty. Further postoperative care is that of any surgical suture line. Bad results are referable chiefly to "slipping" of the pack downward, failure to close a "sliding" cavity and occasional extrusion of the material through the incision area. We have seen the latter occur once and curative thoracoplasty was performed after paraffin had been removed. Removal of paraffin is not necessarily indicated in cases characterized by failure of the cavity to close; thoracoplasty is often performed over a pack which need not be disturbed. Occasionally following closure of large cavities by this procedure, as well as by thoracoplasty, auto-tuberculinization occurs but is generally transient in character. One case is recalled in which a rather large cavity was so closed. Shortly thereafter, an extensive allergic polyarthritis occurred, developing in exactly the same series of joints involved in a rheumatic process of then unknown etiology twenty years before.

Differing from "paraffin plombage," maintenance of the extrapleural pocket by air requires close attention and frequent refills after surgery. Subcutaneous tissues and skin having been closed tightly at operation and cough rigidly controlled to minimize danger of subcutaneous emphysema and loss of collapse, refills are begun under fluoroscopic control, not later than the first postoperative day. A procedure of great value in selected cases, extrapleural pneumothorax has the advantage of being more easily "reversible" and its pressures more easily controlled than in the case of paraffin pack. Certain potential disadvantages likewise exist, including, among others, loss of collapse and development of fluid or pus in the pocket, such loss of collapse resulting from the tendency of extrapleural pneumothorax to shrink rapidly, with the floor of the pocket crawling upward, if frequent refills are not given. The latter produce rapid swings to high pressures with relatively small quantities of air but without the harmful effects that might be anticipated. Moderate positive pressures are well tolerated, especially after the suture lines have become strong. Subsequent maintenance does not differ materially from that of classical intrapleural pneumothorax and results are frequently as gratifying. If, however, in spite of adequate control, the space continues to shrink, replacement oleothorax or thoracoplasty, if safe, is frequently employed. Some men, in fact, feel that virtually every extrapleural pneumothorax must be supplemented eventually by one of these procedures. This dogma is open to some question; however, if correct, it is likewise true that many cases never would reach the stage where thoracoplasty could safely be attempted if preliminary improvement under extrapleural pneumothorax had not resulted.

Intrapleural Pneumonolysis

Intrapleural pneumonolysis, or cutting of adhesions, has a definite place in converting inadequate pneumothorax into a successful procedure. In general, a pneumothorax which has not converted sputum and closed cavities in six months should be either abandoned or reinforced by some other form of therapy. When realized that a statistically important number of established pneumothoraces are ineffectual because one or more intrapleural bands prevent desired collapse and when recognized that pneumonolysis will convert about 70 per cent of those operated upon into a successful result with closure of cavity and conversion of sputum, value of this procedure becomes manifest. Although true that a good thoracoplasty is superior to a poor pneumothorax, conversely an efficient pneumothorax is preferable to thoracoplasty; and any procedure capable of performance under local anaesthesia which, in approximately three out of four selected cases, will obviate the necessity for major surgery is a valued weapon in the armamentarium of the phthisiologist.

The typically suitable case presents one or more fairly thin, long adhesions adherent to

the area in which collapse has been ineffectual. Not all unsuccessful pneumothoraces are susceptible to this form of attack, nor do non-restraining adhesions require cutting. Necessary prerequisites include establishment of a satisfactory pneumothorax space through which the operator may work easily and relative assurance that there is neither pulmonary nor highly vascular tissue included in the adhesive bands. Preoperative stereoscopic films are of aid in visualizing the course of adhesions, although realized that these structures as viewed through the thoracoscope rarely exactly duplicate those seen on x-ray. Generally, a greater number is found at operation and often what has appeared to be a linear string by x-ray is found to represent the edge of a broad, partially non-visualized adhesion seen in cross-section. Wide short adhesions generally are not technically amenable to cutting. Division of these structures frequently leads either to hemorrhage or development of empyema. Transient effusions may develop in any case but much less often when a high frequency cutting apparatus is used. The latter, furthermore, is safer since adhesions can be attacked by both coagulating and cutting units.

We do not see any great indication for open intrapleural pneumonolysis. In cases not suitable for the closed method we believe that, with very few exceptions, thoracoplasty is preferable.

Phrenic Nerve Surgery

"Temporary phrenic" nerve surgery has a limited place in treatment of pulmonary tuberculosis, we believe, and its use is declining. Its chief availability seems to lie in predominantly basal disease for which elevation and immobilization of the diaphragm may be definitely beneficial. We have also used it to furnish supplementary lung relaxation when a broad fan-like adhesion at the apex has prevented adequate collapse by pneumothorax already established. Occasionally, beneficial results are noted when a "phrenic" is used to obliterate a residual pneumothorax space through which a collapsed lung has failed to re-expand. Incidentally, this may be further aided by bronchoscopy which helps re-expand an atelectatic lobe, provided failure of re-expansion is not due to a pleura greatly thickened by fluid. In unre-expanded lungs, some success has followed oxygen lavage of the pleural space.

Phrenic surgery is especially contraindicated if any possibility exists that thoracoplasty will be employed within the succeeding six months. In such an instance, maintenance of diaphragmatic function is indicated since ability to raise sputum and fully ventilate the lower lobes is highly desirable, following thoracoplasty. We feel that permanent phrenic interruption is practically never indicated.

Miscellaneous Procedures

In conclusion, brief reference will be made to a group of related, but not purely surgical procedures. Relatively continuous external suction of large cavities (Monaldi drainage) is frequently followed by improvement in general condition, lessening of toxemia and better preparation for thoracoplasty. It may itself close a cavity in a patient in whom thoracoplasty is contraindicated, but sufficient trial has not been given a large enough number of cases in this country to warrant positive conclusions concerning it. Oleothorax is sometimes indicated. It can be used to check unwanted re-expansion of a successful pneumothorax; we have occasionally seen it employed effectively in patients living far from the sanatorium and unable to return for frequent air refills. It possesses therapeutic value in certain cases of tuberculous empyema, but due to danger of lung perforation, accumulation of high intrapleural pressures, etc., we believe its adaptability generally less than that of thoracoplasty. Pneumoperitoneum has a limited application, we feel, but in a few selected cases where tuberculous enteritis has accompanied pulmonary disease not amenable to other forms of therapy, we have seen improvement in both conditions. In general, however, its availability seems definitely circumscribed.

Conclusion

In the above discussion an attempt has been made to summarize a large and important subject. Through limitation of space much has been omitted, purely technical discussion has been restricted and many may differ from conclusions and interpretations drawn. We feel, however, that all will agree

that results following thoracic surgery now speak favorably for themselves and that it will continue to play an increasingly important role in treatment of this disease. Only by its use, in conjunction with all other accepted forms of attack, can tuberculosis be relegated to that position now held by smallpox, diphtheria and other human maladies that have been controlled.

A Review of the Methods of Early Diagnosis of Pulmonary Tuberculosis

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With the declining incidence of tuberculosis there has arisen an unjustified feeling of complacency and security. The facilities for the diagnosis and treatment of pulmonary tuberculosis have improved and increased in the last two decades; widespread campaigns have been waged to get the cooperation of the laity, but even so, as far as early diagnosis goes, the results have been disappointing. Twenty years ago only 5 to 10 per cent of the average sanitorium admissions were in the minimal stage of the disease and 75 per cent in the moderate or far-advanced stages. Today, the percentage is unchanged. Most of our admissions are still advanced cases. Since our methods of control depend upon early recognition of latent and clinical tuberculosis, we must remember to be on the lookout for the disease before that time when the patient complains of chest symptoms, for there is an insidious lag between pathological involvement and the development of symptoms. There is also a second lag, that between the appearance of the first symptoms and the date when the patient consults a physician. This was estimated to be about 8.8 months.[1]

Early cases have been largely found by mass examination methods. Routine x-raying of the positive reactors to the tuberculin test reveals many healed, many innocent, many early lesions as well as advanced disease. Even so, it is the general practitioner who is largely responsible for referring patients to the clinic or hospital, and he must be vigilant and must make use of our present knowledge to facilitate early diagnosis.

The essential factors in diagnosis are found in the familiar procedures of history, physical examination, laboratory tests, and x-ray. There is no one procedure that supersedes all others.

History

Many of the patients and too many physicians seem to think that the only necessary requisite for the diagnosis of tuberculosis is an x-ray of the chest. A careful history is as necessary as in any other disease. It is of the utmost importance to learn whether there has been any exposure to tuberculosis, whether the contact has been direct, or casual, or intermittent. Predisposing illnesses such as measles, pneumonia, influenza, or pleurisy are inquired into. The previous existence of an erythema nodosum is suggestive. As for the local symptoms (cough, sputum, chest pain, dyspnea, and hemoptysis) and the general symptoms of the disease, they are of great importance, but we must remember that these same symptoms occur in too many other diseases to be completely characteristic. These symptoms when severe and present in combination almost unfailingly bring tuberculosis to mind. It is when the symptoms are too slight to be noticed or remembered that the physician must keep questioning the patient. For example, a patient has vague digestive disturbances, heartburn, pain after meals and belching, yet examination of the gastrointestinal tract shows no disease because the underlying cause is in the lungs. Recent fatigue, any undue weakness, loss of energy, finicky appetite, slight loss of weight, slight dyspnea, and transient pleural pain may be significant. A change in the menstrual cycle may be the first disorder in young women. Wheezing, if there is no true asthma, may

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indicate tuberculous tracheobronchitis.

Too often we do not realize that an old person is not immune to tuberculosis, and assume that his cough and dyspnea are necessarily cardiac. In women the strain of pregnancy and especially of the puerperium may light up a latent focus. Checking for tuberculosis in pregnant women should be as much a matter of routine as checking for syphilis.

Physical Examination

It should be understood that physical examination should not be confined to the chest but should be complete. The temperature should be taken, but in early stages the patient usually has no fever. However, he frequently has tachycardia which is a more delicate and reliable index of toxicity. The pulse should always be taken.

Physical signs in the chest are frequently slight or absent in a high proportion of reinfection tuberculosis cases. The signs would be expected to vary with the pathology, from very slight to extensive. Unfortunately, the physical signs and anatomical involvement do not correspond. The physical signs seem to lag, especially in well developed and well nourished individuals. Even with extensive lesions a skilled examiner may fail to find much variation from the normal. For example, the honest examiner will admit that in the case of cavities, even large ones, surrounded by healthy lung tissue, it is often impossible to elicit any of the classical physical signs although the x-rays may exactly localize the disease. The wasted body, the pale face with hectic flush, the scrawny neck and melancholy eyes have been much discussed in medical school lectures and textbooks. Many patients, on first consultation, may have advanced tuberculosis of the lungs but the body is still robust. Of course, when the patient has reached the consumptive stage with emaciated chest, retracted supraclavicular fossae, cavernous breath sounds, and consonating rales, the diagnosis is quickly made.

In early disease the findings are usually negative with at most a few crepitant rales at an apex or infraclavicular area. As for the detection of enlarged hilum nodes in children, physical examination is valueless.

Though physical examination is frequently a diagnostic aid of little importance, it must never be omitted. Chest examination is of help in differentiating non-tuberculous pulmonary disease. In this latter type of lesion, rales are more frequently present than in tuberculosis and more widespread, usually basal and often bilateral. There is also more cough and sputum, usually worse in winter, with x-ray plates showing blurring near the heart border or the spine, and above the diaphragm. As a rule in early tuberculosis there are no rales and the patient has fewer symptoms.

Laboratory

Tubercle Bacilli — Positive sputum is unequivocal proof of underlying tuberculosis, but negative sputum does not rule out tuberculosis. This is especially true in early cases, for sputum occurs only with caseation which has broken into a bronchus. When sputum is present, repeated microscopic examination may be necessary to find the bacillus. If this is unsuccessful, concentrations, cultures, and guinea pig inoculations must be made. However, the collection of sputum may be a matter of difficulty. Some patients afraid of the possible discovery of tuberculosis forget to return the bottles or bring in the saliva. Some unconsciously swallow their sputum. For this group and for children a gastric lavage is of great value. The sediment is stained for tubercle bacilli and if microscopic examination fails to reveal them then a culture and guinea pig inoculation are made. At times, staining a throat swab will reveal the germs in patients who deny sputum. Another method of dispensing with gastric lavage is through the use of the laryngeal mirror. The mirror is held above the larynx and the patient gives several short, hacking coughs so that the mirror is sprayed with bronchial secretions. The flat of the mirror is drawn along a slide which is then stained. Cohen and Wood[2], in a series of patients, report 49 positive tests with the use of the mirror, and only 37 with examination of sputum.

Much of the time the diagnosis of tuberculosis lies in the examination of a single sputum specimen. However, sputum tests are often neglected, partly because finding of the bacilli merely indicates the presence of disease, whereas the x-ray indicates the type and extent of the involvement.

Differential Leucocyte Counts — Definite changes in the proportions of lymphocytes when distributed according to young, mature, and old types occur in tuberculosis and are of greater significance than the total lymphocyte count. At the same time each type of leucocyte plays a definite role. The neutrophile is increased when tuberculous abscess formation occurs; the monocyte is important in the formation of new tubercles, and an increased lymphocyte count occurs when the tuberculous lesion is healing.

Red Cell Sedimentation Test—There is an increase in the sedimentation rate in a patient with clinical tuberculosis. If the sedimentation rate gradually decreases, it is good evidence that the patient is doing well. An increase in the rate means an increased activity and usually manifests itself before symptoms or signs.

Neither the differential leucocyte count nor the red cell sedimentation rate is specific for tuberculosis, for they are altered in a number of other conditions. They reflect or confirm the clinical picture but rarely contribute to the diagnosis.

Tuberculin Test

No examination is complete without a tuberculin test. Some physicians believe that the test in the presence of symptoms may cause general and focal reactions. This is true of the old Koch subcutaneous test but the intradermal Mantoux type carries no danger with it. The tuberculin test is probably the most accurate biological test known to medicine. In very grave tuberculosis and in the febrile stages of acute infectious diseases, it may not always be reliable. It indicates the sensitiveness of the tissues to tuberculoprotein and hence discloses any area of disease no matter how small. It shows that a tuberculous infection is present, but gives no information about the anatomical extent or activity of the lesion. Because it gives the incidence of infection it is unsurpassed for case-finding among school children.

Despite all that is written and spoken about the tuberculin test, it is little used in private practice. Too many general practitioners feel that its value lies only in mass surveys.

Extensive tuberculin surveys with x-rays of the positive reactors are being conducted throughout the country and, incidentally, have given us a new problem—the management of apparently healthy persons with x-ray lesions.

In chronic non-tuberculous diseases of the lungs such as bronchiectasis, bronchitis, and lung abscess a negative tuberculin reaction is sufficient to rule out tuberculosis without further examination.

For example, occasionally an acute respiratory infection may manifest itself by apical rales and a soft mottling in the x-ray plate. A tuberculin test is not made and the patient is hospitalized in a tuberculosis sanatorium. In time the process clears. A negative tuberculin reaction would have pointed to a bronchopneumonia at the outset.

X-Ray

The next step in the diagnosis is the x-ray film. It is truly wonderful how much light the x-ray film has thrown on chest diseases. Properly interpreted x-rays are one of the most accurate procedures known in medicine and therefore of great value in diagnosis. Perhaps if we were forced to limit our means of diagnosis to a single procedure, the x-ray might be considered the most important, but we must remember not to slavishly base our diagnosis on the x-ray alone. It simply indicates the presence, and within limits, the extent and character of the process, but in the last analysis x-ray is a probability rather than a certainty. The x-ray report divorced from all clinical knowledge is not enough. There are conditions where the x-ray is negative and yet the clinician suspects tuberculosis as the patient may have had a hemoptysis and a daily fever. The disease at the onset may not be sufficiently developed to cast a shadow, but an x-ray taken several weeks later may reveal an early infiltration.

Radiography is unsurpassed for the study of fine detail. It also forms an important part of the record of the case and is of inestimable value for future comparative or serial study in determining the progress of a given lesion. In very early stages all that can be seen is congestion in either upper lobe along one of the trunk branches. The normal visible linear pulmonic markings may extend farther out into the periphery than usual. It is not justifiable to diagnose tu-

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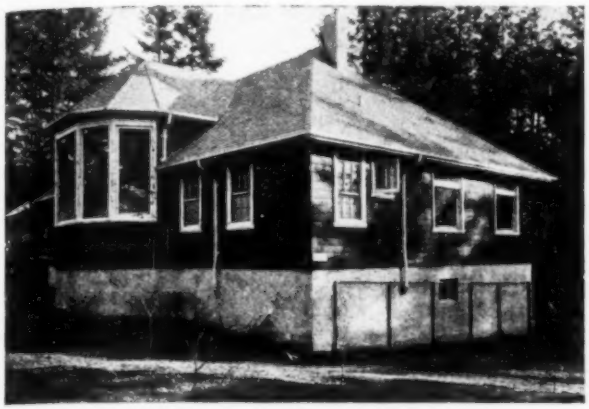

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berculosis from this alone, for there is nothing characteristic about this congestion; it is simply the hypervascularity of any inflammatory process. But if tuberculosis is suspected, then another x-ray in two or three weeks may show a disappearance of the process or perhaps a slightly more flocculent infiltration.

In mass surveys, especially adolescents, routine use of the x-ray on all positive tuberculin reactors reveals many healed and innocent lesions as well as active disease. Physical examination of most of the positive reactors usually reveals nothing. X-ray is far more effective.

With more advanced processes, the x-ray picture is more characteristic and interpretation is easier. However, we must remember that it may be difficult to differentiate advanced processes from pneumonia, chronic suppuration, neoplasm, or cardiovascular disease.

Fluoroscopy

Fluoroscopy has two drawbacks: finer infiltrative lesions may be overlooked, and it leaves no permanent record.

Fluoroscopy is of most value in studying the thorax in motion during the various respiratory phases, localizing encapsulated collections of pleural fluid, and in the determination of expansile or transmitted pulsations.

In an evaluation of fluoroscopic, roentgenographic, and physical examination in a tuberculosis case-finding study, Boynton, Diehl and Shepard[3] came to the conclusion that "Fluoroscopic examination is a valuable aid in the diagnosis of adult tuberculosis. When combined with a history of exposure and symptoms fluoroscopic examination detected three-fourths of the minimal and moderately advanced cases and all of the far-advanced."

Most investigators believe that fluoroscopy in mass surveys is more economical, simple, and rapid than the x-ray. Although inferior to x-ray examination, the cases overlooked by fluoroscopy are usually the less significant ones and if examinations are made periodically, the progressive lesion would be detected in a later examination, usually, before the onset of clinical symptoms.

Bronchoscopy

Bronchoscopy is not a routine procedure in the diagnosis of pulmonary tuberculosis, but it yields invaluable information in sputum negative cases, those showing atelectasis, emphysema, and tracheobronchial tuberculosis. When the x-ray picture is negative and the sputum is positive, tuberculosis of the tracheobronchial tract is suspected and so bronchoscopy should be performed. In some cases it diagnoses and localizes the disease. In case of hemoptysis or other symptoms pointing to pathology in the respiratory tract where the x-ray and sputum give negative results a bronchoscopy may show a reddened mucosa of one of the bronchi. If a smear taken then shows tubercle bacilli the etiology and region affected are established.

In conclusion, the disease can be consistently diagnosed in its early stages by periodic examinations with x-rays of all positive tuberculin reactors. If this is not done, those persons who report because of symptoms will be found to have well advanced disease on the first examination. To control tuberculosis we must seek it in the bodies of the apparently healthy.

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References

1 McIntyre, C. J.: "Tuberculosis in General Practice," *Jour. Ind. M. A.*, 31: 599, (Nov.) 1938.
2 Cohen, R. C., and Wood, W. B.: "Mirror Test in Pulmonary Tuberculosis," *Brit. Med. J.*, 2: 65, Jan. 11, 1936.
3 Boynton, Diehl, and Shepard: "Relative Value of Fluoroscopic, Roentgenographic and Physical Examination," *Am. Rev. Tuberc.*, 37: 49, Jan., 1938.

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